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# **BARKING**

**BLACK OAK AND JACK PINE**

## **FENCE POSTS**

**with Sodium Arsenite**

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Until 1952 relatively little was known about the use of chemicals as an aid in barking trees. The tests described in this report were initiated during the winter of 1950 and completed in the fall of 1952. Since these data were collected, much progress has been made toward a better understanding of the principles of chemical barking and its application. Many results similar to those reported herein have already appeared in print. Although the publication of the results of the Illinois tests was unavoidably delayed, the authors believe that the information obtained was significant, and that it will be of value in substantiating the results of other more recent investigations.



# **SODIUM ARSENITE AS AN AID IN BARKING JACK PINE AND BLACK OAK FENCE POSTS**

By K. R. PETERSON, C. S. WALTERS, and W. L. MEEK<sup>a</sup>

**T**HE TREATMENT OF LIVING TREES WITH CHEMICALS to facilitate the removal of bark is a rather recent development. A number of reports have been published on chemical barking research, many of them by persons interested in peeling pulpwood (1, 3, 6, 9).<sup>b</sup> Several chemicals and methods have been tested. Although the results of the tests have varied with regard to species and season and methods of treatment, the technique appears promising as a means of barking trees to be used for products other than pulpwood.

Small trees thinned from Illinois woodlands may be used as fence posts. Most of the species, however, are not naturally durable in contact with soil, requiring preservative treatment to make them so. Wood preservatives do not penetrate bark. Therefore, it is essential that posts be thoroughly barked or peeled before they are given preservative treatment. Hand-peeling, however, is arduous and the best season for hand-peeling is in the spring when the farm workload is heavy. If post-peeling could be made easier or delayed by the use of chemicals until time would be available for the work, more farmers would treat their fence posts, thereby conserving time, money, and raw materials.

## **DEVELOPMENT AND EARLY STATUS OF CHEMICAL BARKING**

The use of chemicals to bark trees probably was first described in a Canadian patent issued to A. R. White in September, 1942 (U. S. Patent issued in July, 1943). Although 11 years earlier Cope and Spaeth (2) described a method similar to White's, they recommended their method for killing trees and not for barking them.

The results of formal tests of barking chemicals and techniques began to appear in the literature about 1946 (3) when the Canadian Forest Products Laboratory described the effectiveness of various chemicals and seasons of treatment and cutting in barking several

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<sup>b</sup> Numbers in parentheses refer to literature citations listed at the end of this report.

pulpwood species. In their early tests, the Canadian researchers applied the barking chemicals to a girdle made at breast height on the tree with a V-shaped knife. The knife was designed to cut a shallow, narrow groove through the bark and into the sapwood. The chemical was prepared as a paste and it was held in contact with the girdle by a band of crinkled paper pulled tightly around the tree and fastened with a tack.

The conclusions drawn from the results of the Canadian tests were published in a series of reports, many of which appeared between 1946 and 1950 (3, 5, 6, 8). In general, soluble arsenic proved to be the best of the chemicals tested prior to 1950 for facilitating bark removal. Trees which were girdled but not poisoned were found to be either similar to untreated control trees in peeling qualities or, in some instances, harder to peel. June, July, and possibly the first part of August were found to be the best months for applying chemicals under Canadian conditions if the bark were to be peeled easily during the fall of the same year. Generally, a minimum period of two months was needed between treating and felling the Canadian trees to obtain the best barking results.

Since 1950 a number of reports on chemical barking have been published in this country and in Europe, only a few of which are cited in this publication. The most comprehensive of these reports is probably the one made by Wilcox and his colleagues (11) in 1956 on the work of the cooperative Chemical Debarking Research Project conducted by the State University of New York.

## **CHEMICAL BARKING TESTS MADE IN ILLINOIS**

In 1950 the Illinois Agricultural Experiment Station in cooperation with the Illinois Department of Conservation, Division of Forestry, initiated a study of the use of sodium arsenite for barking post-size trees. The objectives of the investigation were to:

1. Find methods of reducing the cost of peeling fence posts for preservative treatment.
2. Determine whether the method of peeling has an effect on the treatability of posts that are to be cold-soaked in oil-soluble wood preservatives.
3. Determine whether the peeling season could be prolonged by killing the cambium at a time when growing conditions make peeling easiest.
4. Develop a technique which would produce satisfactory results under Illinois conditions.

## MATERIALS AND METHODS

**Trees.** Jack pine (*Pinus banksiana* Lamb.) and black oak (*Quercus velutina* Lam.) were chosen for treatment because a satisfactory number of trees of post-size were readily available on the Mason County State Forest. (The original design also included hickory, but an adequate supply of satisfactory trees was not available in the test area.)

Two hundred and thirty-four pines in a fifteen-year-old plantation were pruned to a height of 7 feet and identified with numbered metal tags. The trees ranged from 2.3 to 5.2 inches in diameter (average diameter was 3.4 inches) at the time they were poisoned. The total height of the pine test trees ranged from 15 to 24 feet, averaging 19.8 feet. With one or two exceptions, the trees contained only one 7-foot post.

One hundred and eight of the 234 oak test trees were located on an area of approximately 2 acres, and the remaining trees were on a second area of similar size and environment. The two areas, located about 3 miles apart, were portions of larger timber stands which apparently had been clear-cut twenty-five years earlier. Only trees which had developed from seedlings, rather than sprouts, were selected for treatment. Most of the trees had pruned themselves to a height of at least 7 feet.

**Barking chemicals.** At the time the investigation was initiated, sodium arsenite appeared to be the most promising of the barking chemicals, and the tests were limited to this compound. Two aqueous solutions were prepared from a technical grade, powdered form of the chemical. One solution, designated as "weak," contained 7.5 gm. of toxicant per 100 ml. of water. The "strong" solution contained 20.0 gm. of sodium arsenite per 100 ml. of water.

A paste form was prepared by mixing 2 parts (by weight) sodium arsenite, 1 part cornstarch, and 12 parts water, and heating the mixture approximately 5 minutes.

**Design of experiment.** This factorial experiment related the effect of dosage, time of treatment, and duration of treatment to the length of time required to hand-peel posts cut from the poisoned trees. Table 1 shows the schedule of treatments for 468 trees included in the study. Tables 2 and 3 show the poisoning and cutting and peeling schedules for 156 3-tree lots. The test trees were randomly assigned to treatments.

The study was divided into two parts. Part I (Table 2) was designed to show the most effective time of the year for applying the different concentrations of sodium arsenite. Thus, three trees of each

Table 1. — Number of Trees Tested Grouped by Treatment and by Species

Treatment	Part I	Part II	Total
<b>Black oak</b>			
Weak solution.....	36	36	72
Strong solution.....	36	36	72
Paste.....	..	36	36
Untreated controls.....	36	18 <sup>a</sup>	54
Subtotal.....	108	126	234
<b>Jack pine</b>			
Weak solution.....	36	36	72
Strong solution.....	36	36	72
Paste.....	..	36	36
Untreated controls.....	36	18 <sup>a</sup>	54
Subtotal.....	108	126	234
Total.....	216	252	468

<sup>a</sup> Overlapping of schedules for Parts I and II reduced the requirements for control trees to 18.

species were poisoned with the weak solution and a similar number with the strong solution, each month from December, 1950, through November, 1951. One year elapsed between poisoning the trees and the time the posts were cut and peeled. Three untreated (control) trees of each species also were cut each month, and the posts were peeled with the poisoned posts.

Part II (Table 3) was designed to show the minimum amount of exposure time required between poisoning and felling to obtain the best peeling results. One hundred and twenty-six trees of each species were poisoned May 15, 1951,<sup>a</sup> a time that was judged to be favorable for "sap-peeling" (barking posts during the spring when it is made easier by physiological and anatomical changes in the tree). Nine treated trees and three untreated controls of each species were cut, and the posts were peeled each month following treatment. Thus, exposure times ranged from one to twelve months in length. As Parts I and II overlapped for six months (December, 1951 through May, 1952), one set of control trees served both parts for that period.

**Application of barking chemical.** All trees except the untreated controls were girdled at breast height with a girdling saw (Fig. 1)

<sup>a</sup> Previous experience showed that the peak of the sap-peeling season in Illinois occurs about ten days after the hardwood leaves attain full size. This "rule of thumb" and periodic tests on nontest trees were used to set the poisoning date.

Table 2. — Schedule of Treatments for 3-Tree Lots: Part I

Date of treatment		Black oak			Jack pine		
		Treatment		Untreated controls	Treatment		Untreated controls
		Weak solution	Strong solution		Weak solution	Strong solution	
Year	Month						
Trees girdled and poisoned							
1950	Dec.....	1	13	..	25	37	..
1951	Jan.....	2	14	..	26	38	..
	Feb.....	3	15	..	27	39	..
	Mar.....	4	16	..	28	40	..
	Apr.....	5	17	..	29	41	..
	May.....	6	18	..	30	42	..
	June.....	7	19	..	31	43	..
	July.....	8	20	..	32	44	..
	Aug.....	9	21	..	33	45	..
	Sept.....	10	22	..	34	46	..
	Oct.....	11	23	..	35	47	..
	Nov.....	12	24	..	36	48	..
Butt posts cut and peeled <sup>a</sup>							
	Dec.....	1	13	49	25	37	61
1952	Jan.....	2	14	50	26	38	62
	Feb.....	3	15	51	27	39	63
	Mar.....	4	16	52	28	40	64
	Apr.....	5	17	53	29	41	65
	May.....	6	18	54	30	42	66
	June.....	7	19	55	31	43	67
	July.....	8	20	56	32	44	68
	Aug.....	9	21	57	33	45	69
	Sept.....	10	22	58	34	46	70
	Oct.....	11	23	59	35	47	71
	Nov.....	12	24	60	36	48	72

<sup>a</sup> The three trees in each lot produced from 3 to 7 7-foot posts. For example, only 1 post was cut from each of the 3 pines in Lot 37; 6 posts were cut from 3 oaks in Lot 13.

designed to cut a groove (kerf)  $\frac{1}{4}$  inch wide. The girdles were cut through the bark and into the sapwood to a depth of  $\frac{1}{4}$  inch.

The sodium-arsenite solutions were applied to the girdles with a pump-type oil can. No measurement was made of the volume of solution applied to each tree, but the dosage was "liberal" (Fig. 2). About 620 ml. of solution were required to treat 72 oaks, an average of 8.6 ml. per tree. About 480 ml. of solution were applied to a similar number of pines, an average of 6.7 ml. per tree.

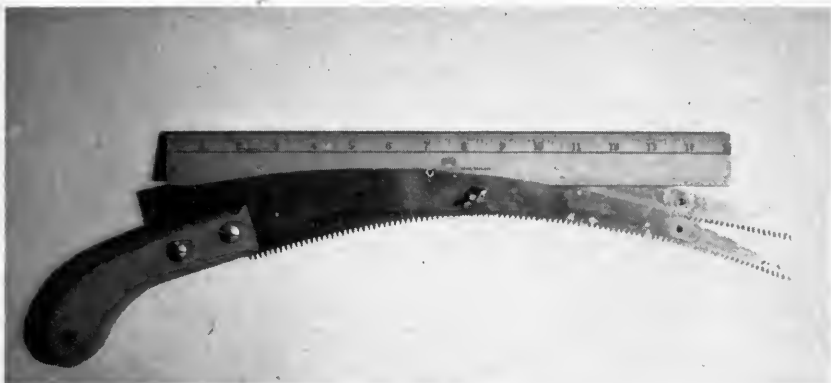
Two men, one girdling and one applying the solution to the girdle, treated 72 jack pine trees at an average rate of 3.4 man-minutes per tree.

The paste was applied with a hand-operated caulking gun (the type commonly used for home maintenance) equipped with a  $\frac{1}{2}$ -inch nozzle.

Table 3. — Schedule of Treatments for 3-Tree Lots: Part II

Date of treatment		Black oak			Jack pine		
		Treatment		Untreated controls	Treatment		Untreated controls
Year	Month	Weak solution	Strong solution	Paste	Weak solution	Strong solution	Paste
1951	May.....	73-84	85-96	97-108	109-120	121-132	133-144
			Trees girdled and poisoned				...
				...			
			Butt posts cut and peeled <sup>a</sup>				
	June.....	73	85	97	109	121	133
	July.....	74	86	98	110	122	134
	Aug.....	75	87	99	111	123	135
	Sept.....	76	88	100	112	124	136
	Oct.....	77	89	101	113	125	137
	Nov.....	78	90	102	114	126	138
	Dec.....	79	91	103	115	127	139
	Jan.....	80	92	104	116	128	140
	Feb.....	81	93	105	117	129	141
	Mar.....	82	94	106	118	130	142
	Apr.....	83	95	107	119	131	143
	May.....	84	96	108	120	132	144
1952							
							151
							152
							153
							154
							155
							156
							61
							62
							63
							64
							65
							66

<sup>a</sup> The three trees in each lot produced from 3 to 7 7-foot posts. For example, 3 posts were cut from the 3 pines in Lot 109; 7 posts were cut from 3 oaks in Lot 73.



This girdling saw, shown partially disassembled, was built of two pruning-saw blades spaced about  $\frac{1}{4}$  inch apart with flat washers. Two stove bolts and wing nuts held blades in position. Although the saw was used to girdle all trees treated with sodium-arsenite solutions, it was rated as an unsatisfactory tool for this purpose. Bark clogged the space between the blades, and the girdle was believed to be too narrow for best results. Wider spacing of the blades might have overcome the objectionable features. Other features of the tool, such as its lightness and cutting speed, were quite satisfactory. (Fig. 1)

A pump-type oil can was used to apply the sodium-arsenite solutions to girdled trees. The first portion of the solution applied was readily absorbed; treatment was stopped when the tree no longer promptly absorbed the solution and the liquid began to flow down the trunk. A small paint brush probably would be a less tiring and quicker method of applying the solution than the oil can.

(Fig. 2)



The gun held about 430 gm. of paste and one loading treated about 20 pines, an average of 21 gm. of paste per tree or 6.5 gm. of paste per inch of tree diameter. The authors concluded that the paste-gun method of poisoning would not be practical for a commercial operation, particularly where girdles wider than  $\frac{1}{2}$  inch were used.

**Collection and analysis of peeling data.** An axe, a bark spud made from a section of automobile springleaf, and a carpenter's draw knife were used interchangeably to peel the posts. The choice of tool depended on which one was best suited for the post being peeled. The posts were supported in a "buck" during the peeling operation (Fig. 3). Posts cut during freezing weather were stored overnight in a warm room and peeled there the following day.

Peeling times were measured with a stop watch and recorded on data forms together with a narrative description of results.



Test posts were held in a "buck" during the peeling operation. The legs of the peeling buck were set in the soil to a depth of about 2 feet to give the equipment stability. The operator is using a carpenter's draw knife to peel the post. (Fig. 3)



The measurement data were punched on cards, and the organization and computation of the data were made by business machines.

Only one post was cut from each pine tree, but from one to three posts were cut from each oak tree. Since missing values complicated the analyses, the analyses of variance (Tables 5, 7, 9, 11) apply only to data for the butt posts.

The diameters in inches and the peeling times in seconds for the butt posts were analyzed statistically. Differences in diameters were not a significant source of variation. However, the differences among peeling times were found to be significant, and an analysis of variance was made for each group of species data to determine the effects of treatment, month, and the interaction of treatment and month.

A hypothesis that peeling times fitted a cyclical pattern over the four seasons of the year was tested using first and second harmonics. The test showed no significance and the hypothesis was rejected.

## RESULTS

### Part I: Effect of Season on Peeling Time

**Pine.** The month of treatment and average peeling times for jack pine posts which were cut and peeled one year after the trees were poisoned are shown in Table 4 and Figure 4.

An analysis of variance (Table 5) for the peeling data showed that treatment, month, and their interaction were highly significant sources of variation. This means that the variation of peeling time from month to month was characteristic of the treatment applied, as shown in Figure 4. Since the two sources of variation were interdependent in their effects on peeling time, the average independent effects of the two variables on peeling time become relatively unimportant.

Treating with the strong sodium-arsenite solution in August gave the lowest peeling time for posts cut from jack pines that were poisoned each month and felled one year later (Lots 25 to 72, Table 2). The poisoned posts were peeled at a rate averaging 97 seconds per post, and the untreated posts were peeled at the height of the sap-peeling season at a rate averaging 62 percent slower (157 seconds per post).

The control trees peeled most rapidly from April through August. During this time poisoning was detrimental, or at best neutral, except for the strong solution applied in August. The sap-peeling season for jack pine appeared to be somewhat longer than that for oak.

Table 4.—Average<sup>a</sup> Diameters and Peeling Times for 7-Foot Jack Pine Butt Posts: Part I

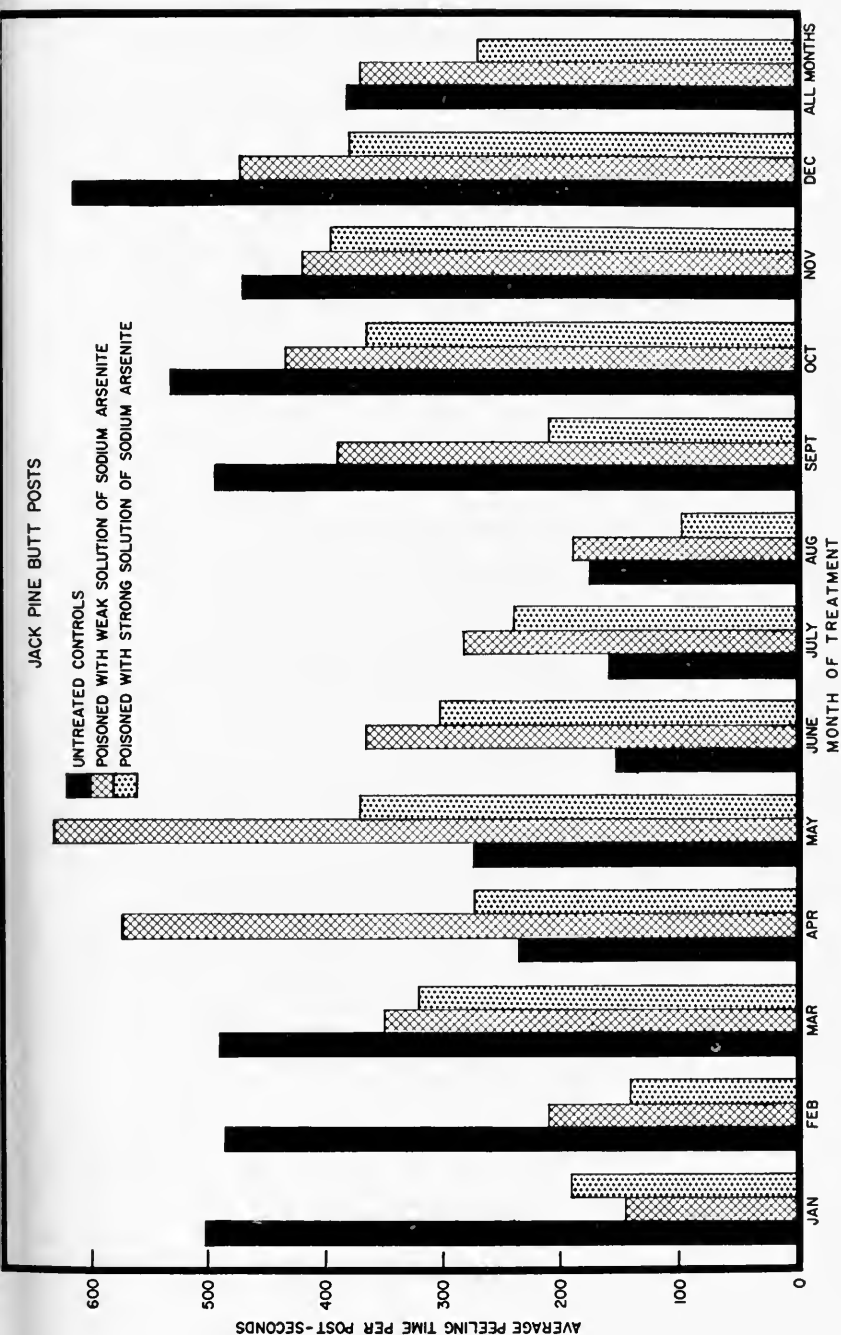
Posts cut from healthy trees and from trees poisoned monthly with sodium-arsenite solutions. Treated trees exposed to poison one year before posts were cut and barked.

Month of treatment	Untreated controls		Treatment				All posts	
	Average midpoint diameter	Average peeling time	Weak solution <sup>b</sup>		Strong solution <sup>c</sup>		Average diameter	Average peeling time
			Average midpoint diameter	Average peeling time	Average midpoint diameter	Average peeling time		
	inches	seconds	inches	seconds	inches	seconds	inches	seconds
Jan.....	3.3	500	3.6	143	2.9	190	3.3	278
Feb.....	3.2	483	3.2	210	3.7	140	3.4	278
March.....	3.8	490	2.8	350	3.0	320	3.2	387
Apr.....	3.3	237	3.4	573	3.0	273	3.2	361
May.....	4.0	277	3.4	633	3.2	373	3.5	428
June.....	3.3	157	3.3	367	3.1	303	3.2	276
July.....	3.4	160	3.2	283	3.1	220	3.2	221
Aug.....	3.5	177	3.4	190	3.1	97	3.3	155
Sept.....	3.7	493	3.9	390	3.7	207	3.8	363
Oct.....	3.7	530	3.9	433	3.1	363	3.6	442
Nov.....	4.1	467	2.8	417	3.1	393	3.3	426
Dec.....	3.6	613	3.3	467	3.1	377	3.3	486
Average.....	3.6	382	3.4	371	3.2	271	3.4	342

<sup>a</sup> Average for 3 butt posts.

<sup>b</sup> 7.5 gm. sodium arsenite per 100 ml. water.

<sup>c</sup> 20 gm. sodium arsenite per 100 ml. water.



Average peeling times for 7-foot jack pine butt posts cut from healthy trees and from poisoned trees at various times of the year (Part I). Posts peeled one year after trees were poisoned. (Fig. 4)

**Table 5. — Analysis of Variance for Jack Pine Post-Peeling Data: Part I**  
Peeling times obtained from 7-foot butt posts cut from healthy trees and from trees poisoned monthly. Treated trees exposed to poison one year before posts were cut and barked.

Source of variation	Degrees of freedom	Sum of squares	Mean square	Variance ratio (F) <sup>a</sup>
Treatment.....	2	268,605	134302	16.02***
Month.....	11	991,032	90093	10.75***
Treatment by month.....	22	984,722	44760	5.34***
Error.....	72	603,541	8382	
Total.....	107	2,847,900		

<sup>a</sup> \*\*\* = significant at .001 level.

**Oak.** The effects of treatment at various months of the year on the length of time required to peel black oak posts cut one year following treatment are shown in Table 6 and Figures 5 and 6. Table 7 shows an analysis of variance for the oak-peeling data.

Treatment and month, but not the interaction of these two variables, were highly significant sources of variation (Table 7). Therefore, standard errors and standard deviations for average peeling times for each month and treatment are shown in Table 6.

The lowest average peeling time per post for all treatments combined was recorded for June, 234 seconds (Table 6 and Fig. 6A). The lowest of the average peeling times for the three methods of treatment was for the strong sodium-arsenite solution (Table 6 and Fig. 6B), 313 seconds, although the time was only slightly lower than that for the weak solution (332 seconds). The average peeling times for both

**Table 7. — Analysis of Variance for Black Oak Post-Peeling Data: Part I**  
Peeling times obtained from 7-foot butt posts cut from healthy trees and from trees poisoned monthly. Treated trees exposed to poison one year before posts were cut and barked.

Source of variation	Degrees of freedom	Sum of squares	Mean square	Variance ratio (F) <sup>a</sup>
Treatment.....	2	297,746	148873	20.32***
Month.....	11	408,108	37100	4.85***
Treatment by month.....	22	191,120	8687	1.18 NS
Error.....	72	527,334	7324	
Total.....	107	1,424,308		

<sup>a</sup> \*\*\* = significant at .001 level.

NS = not significant.

Table 6.—Average<sup>a</sup> Diameters and Peeling Times for 7-Foot Black Oak Butt Posts: Part I

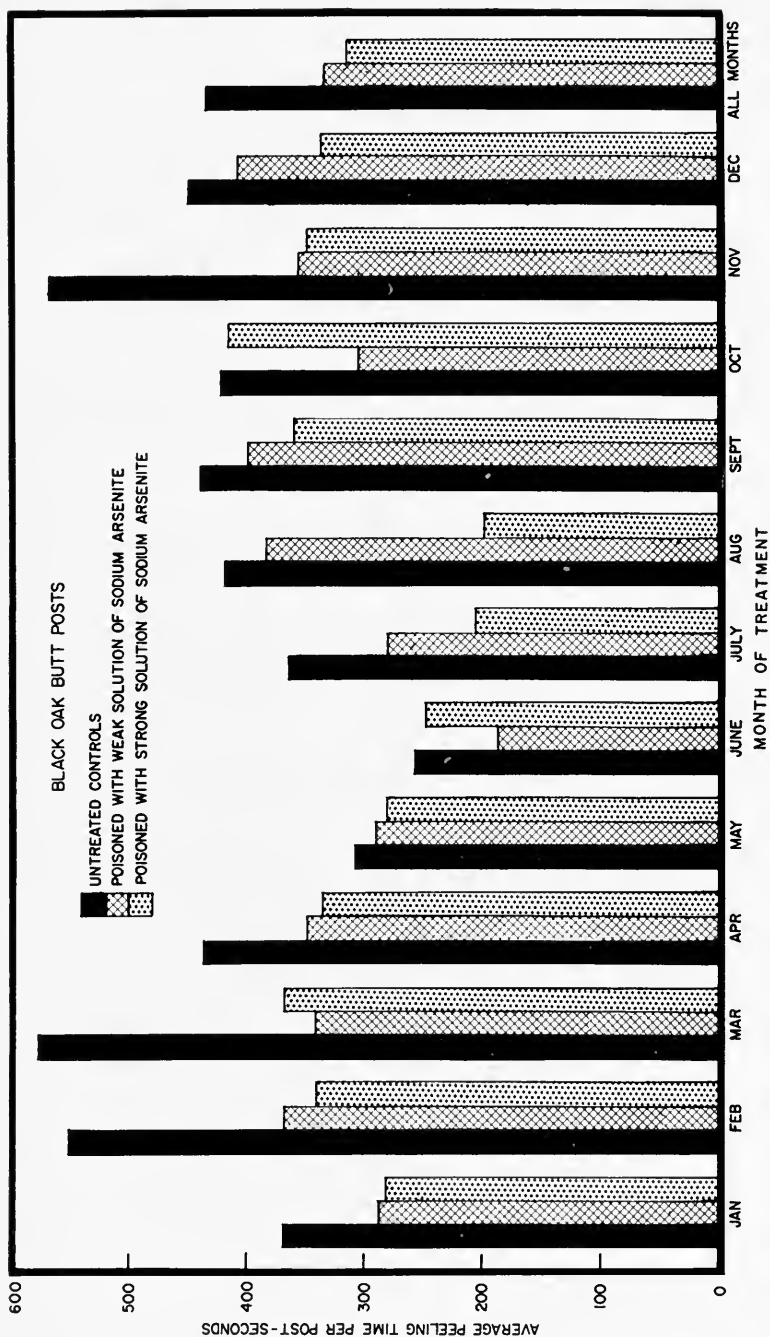
Posts cut from healthy trees and from trees poisoned monthly with sodium-arsenite solutions. Treated trees exposed to poison one year before posts were cut and barked.

Month of treatment	Untreated controls		Treatment				All posts			
	Average		Weak solution <sup>b</sup>		Strong solution <sup>c</sup>		Average diameter		Peeling time	
	midpoint diameter	peeling time	midpoint diameter	peeling time	midpoint diameter	peeling time	inches	seconds	Average	Standard deviation (s)
Jan.....	3.6	370	4.4	287	3.5	283	3.8	313	19	56
Feb.....	3.6	550	4.3	367	3.5	340	3.8	419	128	384
Mar.....	4.1	577	3.7	343	4.3	367	4.0	429	151	453
Apr.....	4.6	437	4.0	350	4.1	337	4.2	375	22	67
May.....	4.2	310	4.0	293	4.0	283	4.1	295	16	49
June.....	3.7	260	3.9	190	3.4	253	3.7	234	19	58
July.....	4.2	367	4.7	283	4.2	210	4.4	287	32	95
Aug.....	4.0	423	4.5	387	3.5	203	4.0	338	112	335
Sept.....	3.9	443	3.4	403	4.4	363	3.9	403	25	74
Oct.....	3.6	427	4.2	310	3.7	420	3.8	386	30	88
Nov.....	4.3	573	4.0	360	4.4	353	4.2	429	210	630
Dec.....	3.9	453	4.0	410	4.3	340	4.1	401	24	71
Average.....	4.0	433	4.1	332	3.9	313	4.0	359		
Standard error ( $S_{\bar{x}}$ ).....		73		14		13				
Standard deviation (s)...		437		82		79				

<sup>a</sup> Average for 3 butt posts.

<sup>b</sup> 7.5 gm. sodium arsenite per 100 ml. water.

<sup>c</sup> 20 gm. sodium arsenite per 100 ml. water.



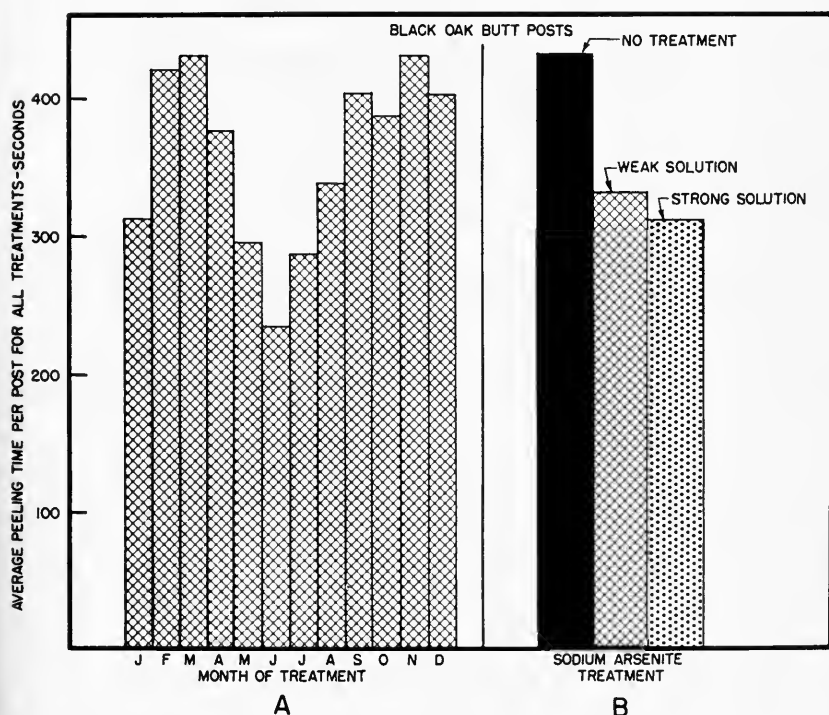
Average peeling times for 7-foot black oak butt posts cut from healthy trees and from poisoned trees at various times of the year (Part I). Posts peeled one year after trees were poisoned. (Fig. 5)

poison solutions, 313 and 332 seconds, were lower than that for the untreated control posts (433 seconds). The lower standard deviations for the poisoned posts (Table 6) indicates that the peeling times were more uniform than they were for the control posts.

## Part II: Effect of Length of Exposure to Poison on Peeling Time

**Pine.** Peeling times for jack pine posts poisoned in May, 1951, and subsequently peeled at intervals of one to twelve months, are shown for various treatments in Table 8 and Figure 7.

An analysis of variance for the peeling data (Table 9), shows that the treatment-by-month interaction was very highly significant. This



The effect of treatment on average peeling times for black oak butt posts cut from healthy trees and from trees poisoned monthly with sodium arsenite solutions (Part I). Treated trees exposed to poison one year before posts were cut and barked. A: Peeling times by month of treatment. B: Peeling times by kind of treatment. (Fig. 6)

Table 8. — Average<sup>a</sup> Diameters and Peeling Times for 7-Foot Jack Pine Butt Posts: Part II

Posts cut from healthy trees and from trees poisoned with sodium arsenite in May 1951. Posts cut and peeled at intervals of one to twelve months after poisoning.

Month peeled	Untreated controls			Treatment						All posts	
	Average midpoint diameter	Average peeling time	Length of exposure to poison	Weak solution <sup>b</sup>		Strong solution <sup>c</sup>		Pasted <sup>d</sup>		Average midpoint diameter	Average peeling time
				inches	seconds	inches	seconds	inches	seconds		
June.....	3.8	303	1	3.1	520	3.2	467	3.4	440	3.4	433
July.....	3.2	220	2	3.1	400	3.5	443	3.1	440	3.2	376
Aug.....	3.8	273	3	3.7	453	3.5	437	3.1	463	3.5	407
Sept.....	3.6	407	4	3.3	277	2.6	287	3.5	333	3.3	326
Oct.....	3.9	533	5	3.5	400	3.8	403	3.5	440	3.7	440
Nov.....	3.9	570	6	3.3	693	3.1	470	3.9	403	3.6	534
Dec.....	3.6	613	7	3.3	660	3.9	550	3.4	713	3.6	634
Jan.....	3.2	500	8	3.2	553	2.9	340	2.9	363	3.1	439
Feb.....	3.2	483	9	3.2	570	3.3	500	3.1	513	3.2	517
Mar.....	3.8	490	10	3.2	503	3.7	313	3.3	250	3.5	389
Apr.....	3.3	237	11	3.3	510	3.2	287	3.6	407	3.4	360
May.....	4.0	277	12	3.4	413	3.3	263	2.9	287	3.4	310
Average.....	3.6	409	..	3.3	496	3.3	397	3.3	421	3.4	431

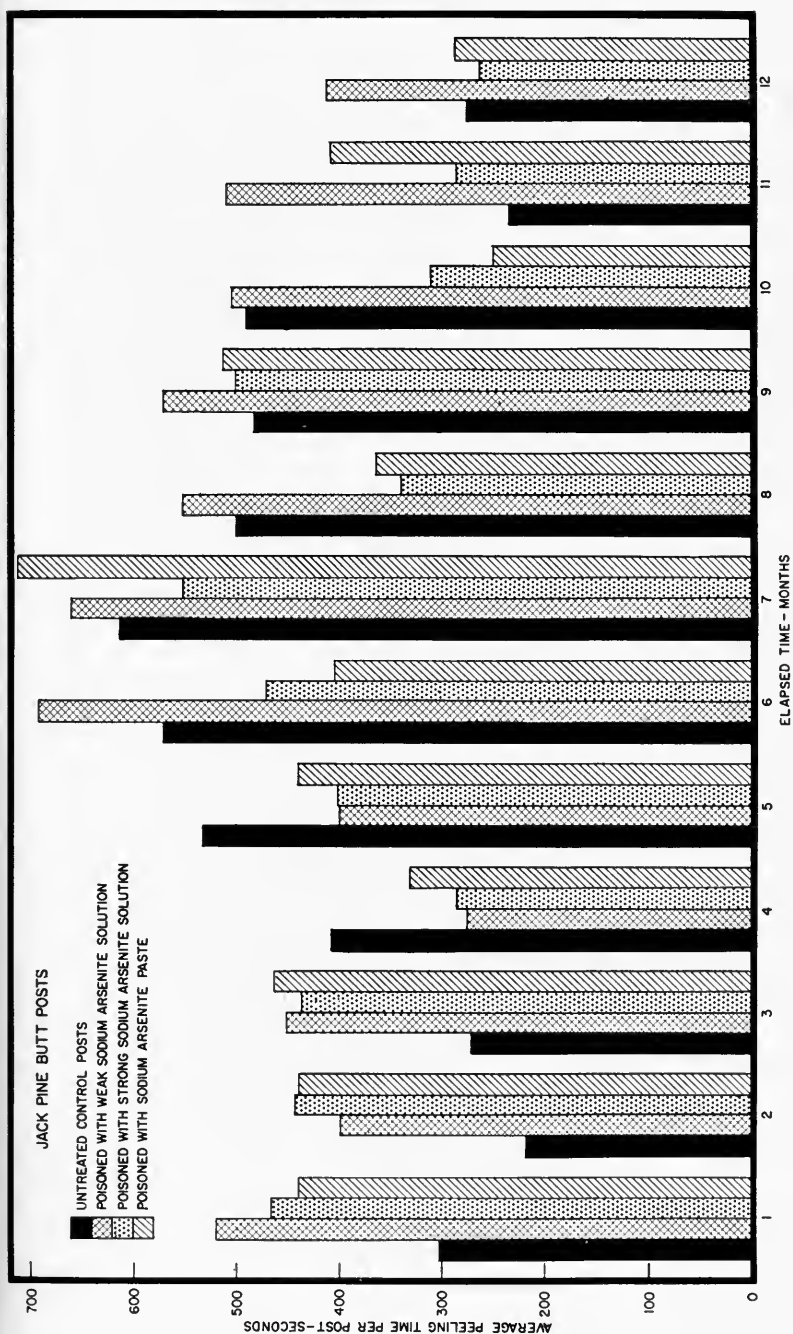
<sup>a</sup> Average for 3 butt posts.

<sup>b</sup> 7.5 gm. sodium arsenite per 100 ml. water.

<sup>c</sup> 20 gm. sodium arsenite per 100 ml. water.

<sup>d</sup> 50 gm. sodium arsenite, 25 gm. starch, and 300 gm. water. Mixture thickened by heating.





Average peeling times for jack pine butt posts cut from healthy trees and from trees poisoned in May, 1951 (Part II). Posts peeled at monthly intervals.

**Table 9. — Analysis of Variance for Jack Pine Post Peeling: Part II**

Peeling times obtained from 7-foot butt posts cut and peeled at intervals of one to twelve months after poisoning in May 1951.

Source of variation	Degrees of freedom	Sum of squares	Mean square	Variance ratio (F) <sup>a</sup>
Treatment.....	3	216,163	72054	5.65**
Month.....	11	1,147,528	104320	7.59***
Treatment by month.....	33	720,630	21837	1.59***
Error.....	96	1,319,210	13741	
Total.....	143	3,403,531		

<sup>a</sup> \*\* = significant at .01 level.

\*\*\* = significant at .001 level.

means that the amount of time required to peel posts varied with the time that elapsed between treatment and peeling in a manner characteristic of the type of treatment applied. Thus, we should look in Table 8 for the combination of treatment and length of exposure to poison before peeling that gave the lowest peeling time.

The untreated control posts cut and peeled in July had the lowest average peeling time (220 seconds) for all lots shown in Table 8.

Although the poisoning treatments and length of exposure to the poisons were different, three of the peeling times were somewhat similar. For posts that were cut from trees poisoned with sodium-arsenite paste in May and peeled 10 months later, the average peeling time was 250 seconds. When the strong solution was used, the best average peeling time, 263 seconds, occurred twelve months after poisoning. One group of posts from the trees treated with weak solution were cut and peeled only four months after treatment, but the average peeling time, 277 seconds, was almost as low as those previously mentioned.

**Oak.** Peeling times for oak posts poisoned in May, 1951, and subsequently peeled at intervals of one to twelve months are shown in Table 10 and Figure 8. In Table 11 an analysis of variance for the peeling data shows that the treatment-by-month (elapsed time) interaction was highly significant, as it was for the pine.

The untreated trees peeled more rapidly in May than the trees treated in May and allowed to stand one year before peeling, the average rates being 213 and 217 seconds, respectively. The lowest average peeling time, 210 seconds, was obtained on the controls peeled in June. This means that the time and chemical used to poison trees to be peeled a year later were wasted.

Table 10. — Average<sup>a</sup> Diameters and Peeling Times for 7-Foot Black Oak Butt Posts: Part II

Posts cut from healthy trees and from trees poisoned with sodium arsenite in May 1951. Posts cut and peeled at intervals of one to twelve months after poisoning.

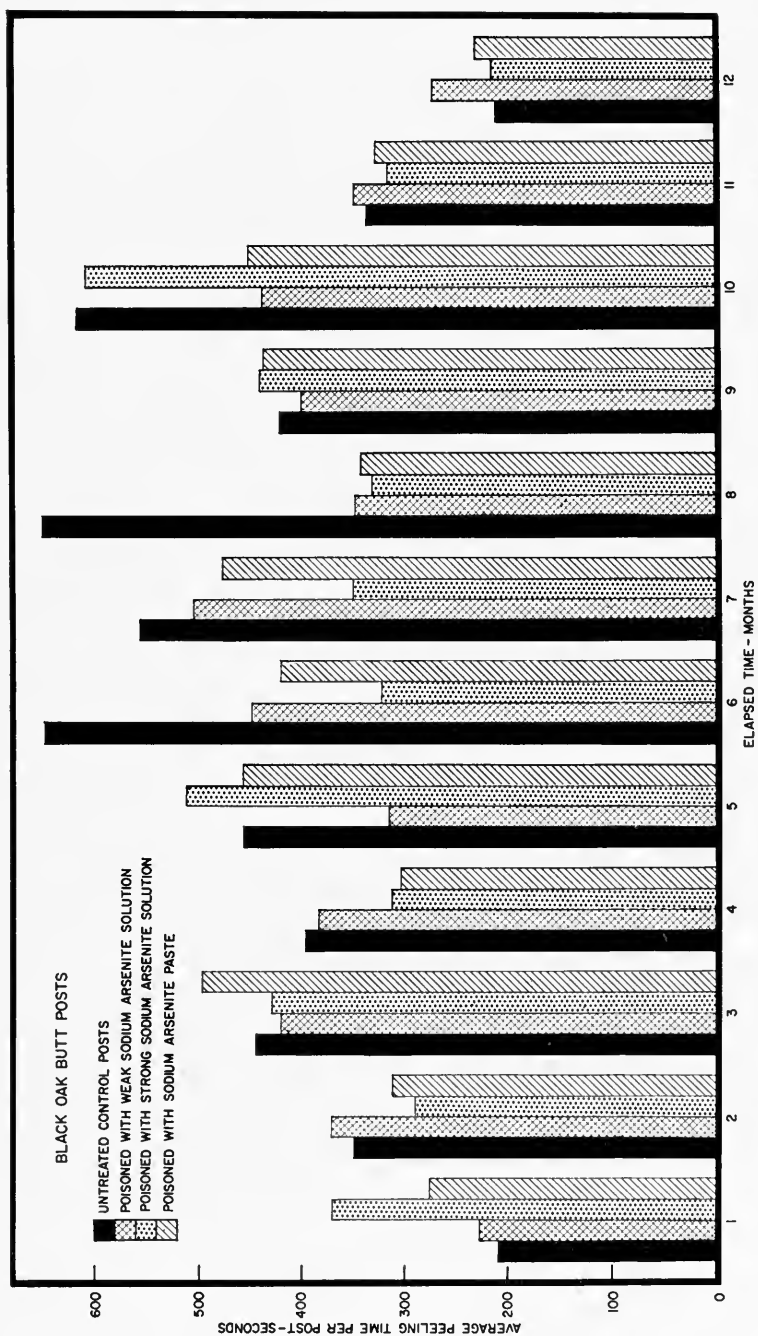
Month peeled	Untreated controls			Treatment						All posts	
	Average midpoint diameter	Average peeling time	Length of exposure to poison	Weak solution <sup>b</sup>		Strong solution <sup>c</sup>		Paste <sup>d</sup>		Average midpoint diameter	Average peeling time
				Average midpoint diameter	Average peeling time	Average midpoint diameter	Average peeling time	Average midpoint diameter	Average peeling time		
	inches	seconds	months	inches	seconds	inches	seconds	inches	seconds	inches	seconds
June.....	4.2	210	1	4.3	227	3.4	370	4.8	277	4.2	271
July.....	3.9	350	2	4.6	370	4.1	290	4.1	313	4.2	331
Aug.....	3.7	443	3	4.1	420	3.8	427	4.4	497	4.0	447
Sept.....	3.5	396	4	3.9	383	3.3	313	3.6	303	3.6	349
Oct.....	4.6	457	5	3.6	317	5.6	513	4.9	457	4.7	436
Nov.....	5.0	646	6	5.1	447	3.5	323	3.6	420	4.3	459
Dec.....	5.0	557	7	4.5	503	4.1	350	4.5	477	4.5	472
Jan.....	4.4	650	8	4.3	347	4.5	330	3.7	343	4.2	418
Feb.....	4.7	420	9	3.2	400	4.6	440	4.4	437	4.2	424
Mar.....	4.9	617	10	3.8	437	4.5	607	5.1	450	4.6	528
Apr.....	3.7	337	11	4.5	350	3.8	317	3.9	327	4.0	333
May.....	3.5	213	12	4.1	273	4.1	217	4.2	230	4.0	233
Average.....	4.3	440	..	4.2	373	4.1	375	4.3	378	4.2	391

<sup>a</sup> Average for 3 butt posts.

<sup>b</sup> 7.5 gm. sodium arsenite per 100 ml. water.

<sup>c</sup> 20 gm. sodium arsenite per 100 ml. water.

<sup>d</sup> 50 gm. sodium arsenite, 25 gm. starch, and 300 gm. water. Mixture thickened by heating.



Average peeling times for black oak butt posts cut from healthy trees and from trees poisoned in May, 1951 (Part II). Posts peeled at monthly intervals. (Fig. 8)

**Table 11. — Analysis of Variance for Black Oak****Post-Peeling Data: Part II**

Peeling times obtained from 7-foot butt posts cut and peeled at intervals of one to twelve months after poisoning in May 1951.

Source of variation	Degrees of freedom	Sum of squares	Mean square	Variance ratio (F) <sup>a</sup>
Treatment.....	3	119,308	39769	3.19*
Month.....	11	1,017,272	92479	7.43***
Treatment by month.....	33	581,909	17633	1.42**
Error.....	96	1,194,028	12437	
Total.....	143	2,912,517		

<sup>a</sup> \* = significant at .05 level.

\*\* = significant at .01 level.

\*\*\* = significant at .001 level.

## DISCUSSION OF RESULTS

The statistical analyses discussed earlier indicated that ease of peeling usually depended on a particular combination of type of treatment and elapsed time since poisoning. It would be helpful to the reader to know the combination that might be used most effectively under conditions similar to those that existed when the experimental treatments were made, but the data do not show clearly the most effective poisoning schedule.

One reason for the confusion is this: Peeling time recorded for a post represented "average" peeling conditions over the 7-foot length. If the post had been poisoned and the cambium only partially killed, however, then peeling time did not represent the true effects of the treatment. As a matter of fact, incomplete kill of the cambium, particularly the area below the girdle, often made peeling more difficult and resulted in an increase in peeling time. Thus peeling times must be balanced by general observations recorded in narrative records.

In general, better results were secured with strong sodium-arsenite solution than with the weak solution or the paste mixture. The strong solution contained about 17 percent toxicant. Although the solution was saturated at all seasons of the year, the toxicant concentration was still below the 30 to 50 percent solutions now recommended for barking trees.

The sap-peeling season for jack pine was from May 15 to August 15 in 1951 and from June 15 to August 15 in 1952. The black oak sap-peeling season appeared to be of shorter duration, May 15 to about June 15 in both 1951 and 1952.

In addition to differences in season and type of treatment, peeling time was probably affected by weather conditions at time of peeling, skill of the peelers, size and quality (knottiness and straightness) of the post, thickness of bark, and the girdling technique used.

Some posts were peeled during freezing weather, and the effect of frozen moisture in the post on ease of peeling is unknown. However, it is believed that posts stored overnight in a heated building and peeled indoors were easier to peel than frozen posts, other conditions being equal.

Most of the peeling was done by two of the authors, although five members of the Forestry Department participated. Every attempt was made by those peeling posts to work at a steady "normal" rate. No acceptable method of evaluating or correcting differences in hand-peeling skill was developed. Wilcox designed a tool which evaluated the effects of treatment (10) by measuring peeling resistance in terms of a gram-centimeter unit of stress, but it too proved a source of variation (7, 11) that could not be measured.

The experimental error probably would have been smaller if all the posts could have been pruned and the pruning scars allowed to heal before the trees were poisoned. The jack pine trees were pruned to a height of about 7 feet from four to twenty months before the trees were cut into posts, but not all the pruning scars had completely healed by the time the posts were peeled. The oaks often developed epicormic branches, which appeared singly or in clusters on the bole of the tree below the girdle. These "knots" created a peeling problem, the effect of which could not be measured in terms of peeling time.

At the time the investigation was designed (1949), it was believed that a 1/4-inch girdle located at breast height would be satisfactory. When the posts were peeled, however, it was noted that the cambium on some posts was killed only in narrow streaks (Fig. 9) or spots, whereas the objective was to kill all of the cambium. An incomplete kill of the cambium area usually made such posts more difficult to peel than nonpoisoned posts. More recent studies (7, 8, 9) have shown that girdles 4 to 12 inches wide are needed to bark post-and-pole-size trees satisfactorily.

In many instances the entire cambium above the girdle was killed and barking results were satisfactory, whereas the cambium below the girdle was only partially killed and the bark was more difficult to remove than that on healthy trees (Fig. 10). It is believed that barking times would have been lower in such cases if the girdle had been located



These two black oak posts were cut from a tree that was girdled and treated with sodium-arsenite paste in May, 1951; the posts were cut and peeled in January, 1952, eight months after treatment. Note the narrow streaks of dead tissue alternated with wide bands of live tissue. The incomplete kill of the cambium area is believed to have resulted mainly from improper girdling of the tree. (Fig. 9)

at a point nearer the root collar. However, girdling the tree at a point below the worker's knees with a tool other than one similar to the Cornell tree-killing tool (2) would be more arduous than girdling the tree at a point on the bole between waist-height and breast-height.

### Effect of Chemical Barking on Preservative Treatment

One of the objectives of this investigation was to determine what effect chemical barking had on the absorption and penetration of oil-soluble wood preservatives. This phase of the study was temporarily abandoned because an adequate supply of suitable posts of a particular barking treatment was not available for the tests. However, Lindgren (4) reported that some fungi increased the permeability of southern pine posts to oil- and water-borne preservative chemicals. In heavily



This black oak post was cut from a tree which was girdled and treated with strong sodium-arsenite solution in May, 1951 at the height of the sap-peeling season; the post was cut and peeled in January, 1952, 8 months following treatment. Note that the bark above the girdle (right hand side) was dead and easily removed. The bark also was dead and loose for about one foot below the girdle, but the remainder of the bark below the girdle was green and tight. Fungi were present in the dead, loose bark adjacent to the girdle. (Fig. 10)

molded wood, the absorptions he obtained from nonpressure treatments often were five times greater than those in uninfected wood.

Mold fungi, of course, have little or no harmful effect on the mechanical properties of wood, whereas decay fungi reduce all strength properties. The first evidence of decay attack on the experimental posts was observed in November, six months after the poisoning treatment. The posts that were easily peeled in this investigation also were infected with cerambycid and buprestid<sup>a</sup> larvae and mold fungi.

The borers were present in the cambial area within one month following treatment of the oak. The first observation of borers in the

<sup>a</sup> The cerambycidae larvae were identified by Dr. C. F. W. Muesebeck, U. S. National Museum, as *Acanthoderes* sp. and *Batyle* sp.; Dr. J. C. Krall, State University of New York, College of Forestry, identified the buprestid larvae as *Chrysobothris* sp.



jack pine was made in September following treatment with sodium arsenite in May. Fewer borers were found in the pine than in the oak.

Unless the preservative treatment can effect deep penetration, the mycelial strands will remain active as long as conditions are favorable for decay. Conditions probably will become favorable for decay of fence posts as soon as the post is set in the fence line. Thus, cold-soaking posts already infected with decay fungi appears to be a questionable practice.

### **Chemical Peeling for the Woodland Owner**

From the woodland owner's standpoint, a schedule that would permit him to poison the trees when the treatment would be most effective and cut and peel the posts (or pulpwood) later in the fall or winter when the farm workload is relatively light would be most beneficial.

Many Illinois farm operators find the period from the middle of April to the middle of May their busiest season of the year.<sup>a</sup> The seasons of relatively light workloads fall in late summer and during the winter, that is, from the middle of July to about the first of September and from the middle of November to the first of February. The peak or depression periods, of course, vary among various types of farms and from one part of the state to another.

Early summer is a busy farming period and farmers ordinarily do not care to schedule peeling or poisoning activities during this period. There are, of course, only a limited number of working hours. For those farmers who cut and treat their own posts, however, an investment of a few hours poisoning trees for a supply of posts might subsequently save several hours of peeling labor, even though the poisoning work conflicted with other farming activities. Although nothing in the study indicated that poisoning jack pine was desirable, since sap-peeling extended over a relatively long period and took no more time than peeling poisoned posts at other seasons, it is believed that chemical barking — when properly done — is less arduous than sap-peeling. Thus, poisoning the trees at the height of the sap-peeling season and cutting and peeling the posts in late summer or during the winter would, it seems, better balance the work schedule on many Illinois farms. Peeling, however, should not be delayed beyond the winter season, because of the danger of insects and decay attacking the dead trees.

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<sup>a</sup> Based upon unpublished data collected by R. A. Hinton, Research Associate in Farm Management, Department of Agricultural Economics.

## SUMMARY AND CONCLUSIONS

Three hundred and sixty post-size trees were girdled at breast height and poisoned with sodium arsenite at various times of the year. One hundred and eight healthy nongirdled trees served as controls. Half of the trees were jack pine and half were black oak. The test trees were subsequently cut into fence posts and the posts were hand-peeled. The sodium arsenite was applied as a "weak" or "strong" aqueous solution, or in mixture with starch paste. Poisoning and cutting schedules were designed to show the effect of poison dosage, time of poison application, and the duration of poison treatment on the length of time required to hand-peel butt posts cut from test trees.

The main results of the poisoning treatments were these:

1. When the trees were poisoned monthly and the posts cut and peeled a year following treatment:

a. There was an interacting effect of treatment and month of treatment on the time required to peel jack pine posts. Applying a relatively strong concentration of an aqueous sodium-arsenite solution to girdled trees in August gave the lowest average peeling time for the species, 97 seconds per post. In comparison, the best average peeling time for nonpoisoned posts occurred in June, when 62 percent more peeling time was required.

b. The interacting relationship between treatment and month of treatment had no statistically significant effect on peeling time for black oak posts, but the independent effects of "month" and "treatment" were statistically significant. The best average peeling time for a particular month was obtained in June, 234 seconds. The average peeling time for posts treated with strong sodium arsenite solution was 313 seconds, results that were superior to all other poisoning treatments.

2. When the trees were poisoned in May, a time that was judged to be favorable for sap-peeling, and peeled at intervals of one to twelve months after treatment:

a. The interaction of treatment and length of exposure to poison had a statistically significant effect on peeling time for jack pine posts. The nonpoisoned control posts peeled in July had the lowest average peeling time, 220 seconds. The poisoning treatments gave inconclusive and somewhat poorer results. Although no single poisoning treatment was outstandingly superior, an exposure period of at least ten months appeared to be needed for best results.

b. The type of treatment given the black oak trees and the amount of time which elapsed between treatment and peeling had an

interacting and statistically significant effect upon peeling time. The poisoning treatments gave peeling times that were slightly poorer than those for the sap-peeled controls, although the differences probably were not statistically significant. The lowest average peeling time was secured on nonpoisoned control posts peeled in June, 210 seconds. The average peeling time for control posts peeled in May was 213 seconds per post, and that for posts poisoned with a strong sodium-arsenite solution and peeled twelve months later was 217 seconds.

The authors concluded that:

1. There were a number of factors in addition to differences in season and type of poisoning treatment that probably had an effect on peeling time; namely, weather conditions at time of peeling, skill of the peelers, size and quality of the post, thickness of bark, and the girdling technique used. No acceptable method of evaluating or correcting for differences in peeling times due to these and other similar factors was developed.

2. Trees should be girdled and poisoned at a point on the bole near the root collar. Girdling a tree at this point, however, would probably be more arduous than girdling at waist-height.

3. The  $\frac{1}{4}$ -inch-wide girdle used to poison the trees apparently was too narrow to permit adequate poisoning of the cambium; removing a band of bark at least 4 inches wide is suggested for trees of post size.

4. The sodium-arsenite solution containing 20 gm. of toxicant per 100 ml. of water was superior to one containing 7.5 gm. of the compounds per 100 ml. of water, and to a boiled-paste mixture containing 13 percent toxicant, 7 percent cornstarch, and 80 percent water.

5. The sodium-arsenite solutions were easier and quicker to apply than the paste mixture.

6. Applying the toxic solution with a brush would be easier, quicker, and less tiring than using a hand-operated pump-type oil can.

7. If chemically barked trees are to be cold-soaked in a wood preservative and used as fence posts, the peeling operation probably should be done within six months of the time they are poisoned; otherwise the posts may become heavily infested with decay fungi.

8. The sap-peeling season for jack pine lasted longer than that for black oak. Although the duration and peak of the sap-peeling season varies from year to year in Illinois, black oak probably peels best from the middle of May to the middle of June, and jack pine from the middle of May to the middle of August.

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